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The Influence of Incompetent Lip Seal on the Growth and Development of Craniofacial Complex

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A B S T R A C T

Abnormal orofacial functions in the period of growth and development can cause morphological anomalies of the craniofacial complex. The aim of this study was to determine the correlation between open mouth posture and morphology of craniofacial complex. The shape, size and relationships of skeletal parts of craniofacial complex were determined by analysis of lateral cephalograms in the sample of 84 children – 45 girls and 39 boys (aged 8.96±0.66 years). The sample was divided into two groups – lip competence and lip incompetence group. Differences in cephalometric values between observed groups were found. The values of inclination of lower central incisors (angle ILi/NB), interbasal angle (NL/NSL), angle between occlusal and mandibular plane and anterior lower facial height were significantly higher in the group with open mouth posture. It can be concluded that lip incompetence plays an important role in growth and development of craniofacial complex.

Key words: *incompetent lip seal, growth and development, cephalograms, craniofacial complex, morphology*

Introduction

Abnormal orofacial functions in the period of growth and development can cause morphological anomalies of the craniofacial complex. Numerous studies tried to show the correlation between abnormal functions (mouth breathing, open mouth posture, abnormal swallowing, sucking habits, and abnormal speech) and craniofacial morphology.

Environmental factors – like breathing disturbances were thought to be the major aetiology for the morphological malocclusion very early in orthodontics[1].

The correlation between upper airway obstruction and craniofacial morphology was also proven in animal experiments. Tomer and Harvold blocked the nostrils of Rhesus monkeys, so they were not able to breath through the nose but forced to breathe through the mouth. Following changes were observed: the elevation of upper lip, the tongue posture on the bottom of oral cavity and the increased anterior lower facial height measured on monkey's lateral cephalograms[2].

Obstructions of the upper airway lead to changes in neuromuscular patterns. Posture of neck, head, lower jaw, tongue and lips are altered[3–5]. It has also been shown that if the obstruction is present during a long period of active growth, facial morphology can be influenced: the mandible rotated posterior, the angle between maxilla and mandible increases, the anterior facial height is larger[6–8].

The shape of the jaw bone undergoes gradual changes in response to external influences, such an abnormal oral function. Their effects on the dentition, occlusion and jaws is related to the mode, frequency and duration of abnormal oral function[9].

Woodside et al. showed that after establishing a free nasopharyngeal airway a tendency toward normalization of facial growth could be observed[10]. The amount of maxillary and mandibular growth and the direction of maxillary growth were studied in 38 children during 5 years after adenoidectomy for correction of severe nasopharyngeal obstruction. The amount of mandibular growth measured between successive gnathion points on superimposed radiographs was significantly greater in the group that had an adenoidectomy than in the matched control groups.

Fränkel claimed that abnormal oral and nasal function, which can be observed as an incompetent lip seal, is one of the most important etiologic factors of morpho-

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logical malocclusions. Competent lip seal is obligatory for balance between buccal and tongue muscles[11].

A very interesting conclusion was claimed by Vig and co-workers. They emphasised that mouth breathing and lip incompetence are not synonymous. This investigation examined the relationship between facial morphology and nasal respiration. Nasal resistance to expiratory airflow, average volume flow rate, and temporal characteristics of the respiratory cycle were measured. Subjects were categorized as having normal facial proportions with competent lips, normal facial proportions with incompetent lips, and long vertical face height. Results of their study indicate that the three groups do not differ significantly in terms of nasal airflow. Although long-faced subjects as a group had a higher average value of nasal resistance, the range of variation was as great as to preclude the diagnosis of nasal obstruction from an assessment of facial morphology[12].

In our previous study the correlation between lip incompetence and orofacial morphology was proven. By carrying out the study cast analysis we have showed the higher prevalence of malocclusions in the lip incompetence group than in the competent lip seal group ($p<0.001$). The structure of malocclusions was also significantly different in the incompetent lip seal group ($p<0.001$). The most frequent malocclusion found in the incompetent lip seal group was Class II/1 malocclusion, in a group with normal lip posture the Class II/1 malocclusion was determined in only 16.67%[13].

The aim of this study was to determine the correlation between open mouth posture and morphology of craniofacial complex. The shape, size and relationships of skeletal parts of craniofacial complex were determined by cephalometric analysis.

Subjects and Methods

The sample of 84 children – 45 girls and 39 boys (aged 8.96±0.66 years) was constituted by random selection from the list of children who visited the third year of primary school in the Ljubljana region.

The methods included: interview, clinical examination of craniofacial complex, cephalometric analysis and statistics.

No previous orthodontic treatment was obligatory to participate in the study. The parents gave their consensus that the children can indeed take part in this research.

According to clinical examination the subjects were divided into two groups: the competent lip seal group and incompetent lip seal group. Children with incompetent lip seal closed their mouth with difficulties – the contractions of m. orbicularis oris and m. mentalis could be observed.

Cephalometric radiograms were obtained from all subjects. They were taken under standard conditions: the distance from focus to the median plane of the patient's head was 150 cm and median plane-film distance amounted to 10 cm. The cephalograms were taken with the subjects standing and the head positioned in the cephalostat and orientated to the Frankfort horizontal plane with the teeth in maximum intercuspation. Radiograms were traced and measured by hand. The magnification of 10% was taken into account in linear mesurements.

All films were traced and subsequently measured twice. The two tracing – measurement procedures were carried out by the same orthodontist. The same orthodontist performed all the measurements, in order to avoid calibration problems.

Cephalometric analysis

The following landmarks were used (Figure 1): nasion (n) – the point where the midsagittal plane intersects the most anterior point of the nasofrontal suture, sella turcica (S) – the center of sella turcica, anterior nasal spine (ANS) – the tip of the anterior nasal spine as seen on the x-ray film in norma lateralis, posterior nasal spine (PNS) – most posterior point on the contour of the bony palate, basion (ba) – the most inferior posterior point in the sagittal plane on the anteior rim of the foramen magnum, articulare (ar) – the point of intersection of the dorsal contours of processus articularis mandibulae and os temporale, A point (A) – the deepest point on the contour of the alveolar projection, between the spinal point and prosthion, B point (B) – the deepest midline point on the mandible between infradentale and pogonion, Sp' point – intersection between nasal plane and n – me plane, incision superior (is) – mid-point on the incisal edge of the most prominent upper central incisor, incision inferior (ii) – the incisal point of the most prominent medial mandibular incisor, upper

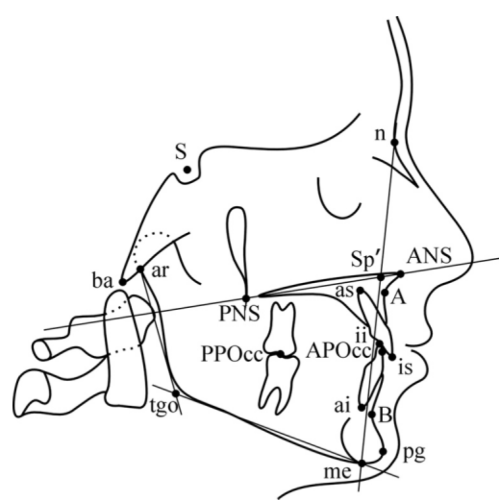


Fig. 1. Landmarks used in cephalometric analysis: n – nasion, S – sella turcica, ANS – anterior nasal, PNS – posterior nasal spine, ba – basion, ar – articulare, A – A point, B – B point, Sp' point – intersection between nasal plane and n – me plane, is – incision superior, ii – incision inferior, as – upper incisor apex, ai – lower incisor apex, APOcc – anterior occlusal point, PPOcc – posterior occlusal point, pg – pogonion, me – menton, tgo – gonion.

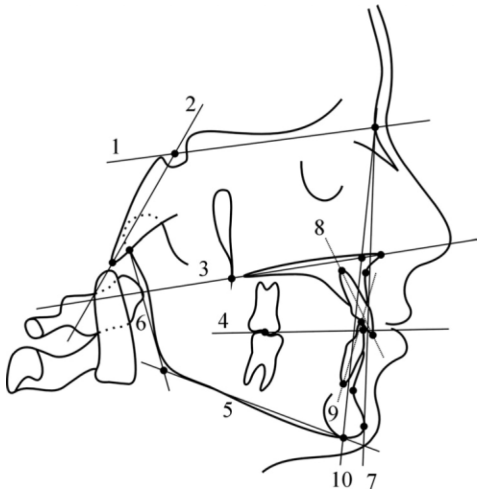


Fig. 2. Reference lines: (1) NSL: nasion – sella line (n – S), (2) sella – basion line (S – ba), (3) NL: nasal line (ANS – PNS), (4) OccP: occlusal line (APOcc – PPOcc), (5) ML: mandibular line – tangent from menton to the lower border of corpus, (6 tangent of mandibular ramus ascendens), (7) nasion – pogonion line (n – pg), (8) ILs: long axis of the upper incisor (is – as), (9) ILi: long axis of the lower incisor (ii – ai), (10) nasion – menton line (n – me).

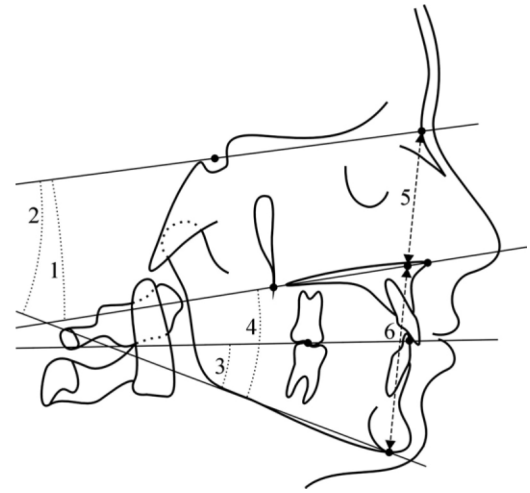


Fig. 4. Skeletal verical measurements: (1) maxillary prognathism: SNA (°), (2) mandibular prognathism: SNB (°), (3) chin prognathism: SNpg (°), (4) jaw relationship: ANB (°).

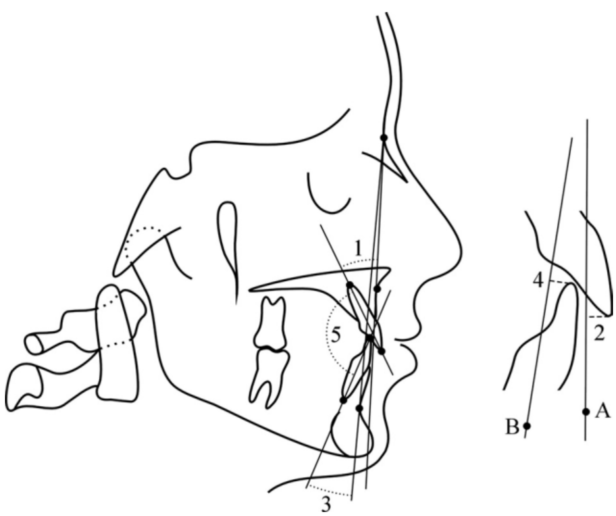


Fig. 3. Dental measurements: (1) inclination of the upper incisors: ILs/NA (°), (2) protrusion of the upper incisors: is ⊥ NA (mm), (3) inclination of the lower incsors: ILi/NB (°),(4) protrusion of the lower incisors: ii ⊥ NB (mm), (5) interincisal angle: ILs/ILi (°).

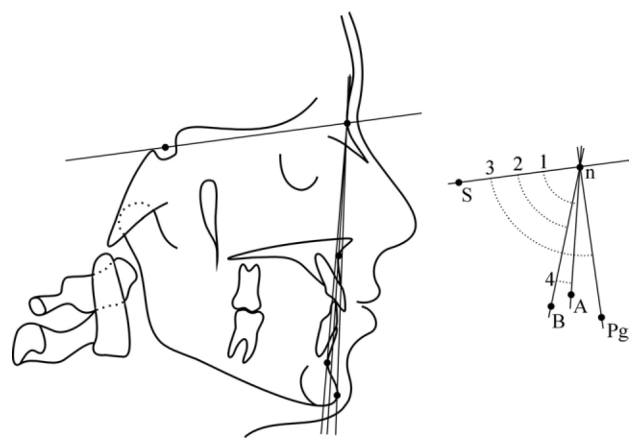


Fig. 5. Skeletal vertical measurements: (1) inclination of the maxilla: NL/NSL (°), (2) inclination of the mandible: ML/NSL (°), (3) occlusal line – mandibular line: OccP/ML (°), (4) interbasal relationship: NL/ML (°),(5) upper anterior facial height: N – Sp' (mm), (6) lower anterior facial height: Sp' – me (mm).

incisor apex (as) – the root apex of the most prominent upper incisor, lower incisor apex (ai) – the root apex of the most prominent lower incisor, anterior occlusal point (APOcc) – the mid-point of the incisor overbite in occlusion, posterior occlusal point (PPOcc) – the most distal point of the contact between the most posterior molar in occlusion, pogonion (pg) – the most anterior point on the symphisis of the mandible, menton (me) – the lowest point of the contour of the mandibular symphisis, gonion (tgo) – intersection between mandibular line (ML) and ramus line.

The reference lines used are shown in Figure 2. The measurements, which are part of cephalometric analysis used at the Department of Orthodontics, University of Ljubljana, were carried out (Figure 3, 4, 5).

Differences between competent lip seal and incompetent lip seal group were tested with two-way analysis of variance (ANOVA).

Results

84 children were included in the study. The competent lip seal was determined in 64.28 % – in 54 children and incompetent lip seal in 35.72% – in 30 children.

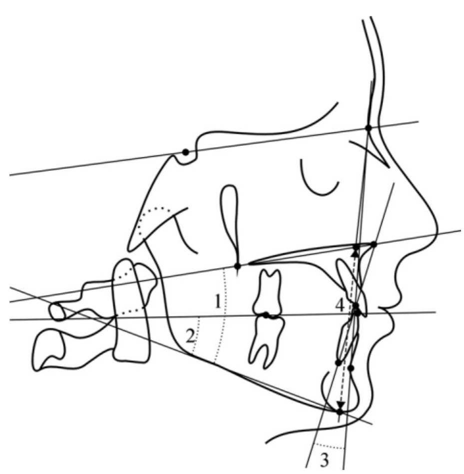
Descriptive statistics for the cephalometric measurements of the competent and incompetent lip seal group are shown in Table 1.

TABLE 1
CEPHALOMETRIC MEASUREMENTS IN COMPETENT AND INCOMPETENT LIP SEAL GROUP

Measurement	Competent lip seal				Incompetent lip seal				p
	X	SD	Min	Max	X	SD	Min	Max	
Dental measurements									
ILs/NA (°)	23.92	8.58	6.00	33.00	21.61	5.35	13.00	34.00	ns
is ⊥ NA (mm)	3.81	4.18	2.00	6.00	5.62	10.13	0.00	7.00	ns
ILi/NB (°)	21.69	7.67	2.00	33.00	26.61	6.56	14.00	44.00	p<0.001
ii ⊥ NB (mm)	2.58	2.17	5.00	6.00	4.43	2.46	0.00	9.00	ns
ILs/ILi (°)	131.08	12.28	113.00	175.00	126.74	10.11	105.00	145.00	ns
Skeletal vertical measurements									
NL/NSL (°)	13.08	3.90	6.00	20.00	14.30	4.80	6.00	16.00	ns
ML/NSL (°)	35.73	5.73	25.00	49.00	36.48	5.74	21.00	44.00	ns
NL/ML(°)	22.27	5.27	13.00	35.00	26.30	4.97	17.00	34.00	p<0.001
OccP/ML (°)	15.27	3.39	8.00	22.00	17.57	3.79	10.00	25.00	p<0.001
n – Sp (mm)	48.08	3.36	41.00	56.00	48.74	4.69	41.00	63.00	ns
Sp – me (mm)	60.00	3.82	51.00	61.00	63.26	4.68	49.00	72.00	p<0.05
Skeletal sagittal measurements									
SNA (°)	79.88	3.42	72.00	88.00	81.00	3.31	77.00	89.00	ns
SNB (°)	76.96	3.22	71.00	83.00	76.35	3.18	70.00	84.00	ns
SNpg (°)	77.85	3.36	72.00	84.00	77.26	3.85	71.00	87.00	ns
ANB (°)	3.00	2.30	0.00	8.00	4.83	2.30	1.00	10.00	ns

ILs/NA – inclination of the upper incisors, is ⊥ NA – protrusion of the upper incisors, ILi/NB – inclination of the lower incsors, ii ⊥ NB – protrusion of the lower incisors, ILs/ILi – interincisal angle, NL/NSL – inclination of the maxilla, ML/NSL – inclination of the mandible, NL/ML – interbasal relationship, n – naison, Sp point – intersection between nosal plane and n-me plane, me – menton, OccP – occlusal line, ML – mandibular line, SNA – maxillary prognathism, SNB – mandibular prognathisM, SNpg – chin prognathism, ANB – jaw relationship

a)



b)

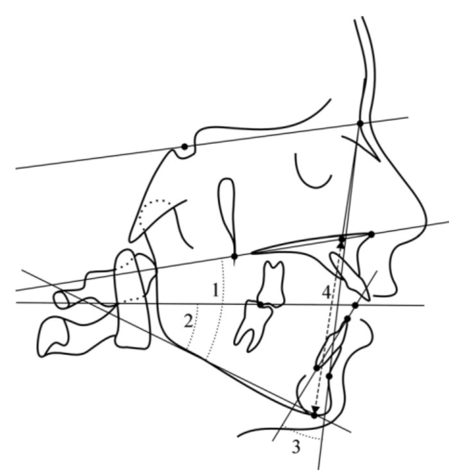


Fig. 6. Significant differences in cephalometric parameters between lip competence (A) and lip incompetence group (B). Interbasal angle (1-NL/ML): 22,27° (A), 26.30° (B) (p<0.001), inclination of mandible (2-OccP/ML): 15.27° (A), 17.57° (B) (p<0.001), inclination of the lower incsors (3-ILi/NB): 21.69° (A), 26.61° (B) (p<0.001), lower anterior facial height (4 – Sp' – me): 60.00 mm (A), 63.26mm (B) (p<0.05).

Differences in cephalometric values between lip competence and lip incompetence group were found. Lower central incisors are more proclined in incompetent lip seal group. The distance between the incisal point of the most prominent medial mandibular incisor (ii) and NB line is significantly larger in incompetent lip seal group then in group with normal mouth posture (p<0.001).

There are also differences in skeletal vertical relationships. The inclination of maxilla (NL/NSL) and the inclination of mandible (ML/NSL) are larger then in normal group, but the differences are not statistically significant.

Significant differences between observed groups were found in the interbasal relationship (NL/ML), OccP/ML angle (p<0.001) and in the anterior lower facial height (p<0.05). Children with incompetent lip seal had larger values of these measurements.

Sagittal skeletal relationships in both groups differ the most in the value of ANB angle, but this difference is not significant.

Significant differences in cephalometric parameters between both observed groups are presented in Figure 6.

Discussion

The aim of our study was to determine the influence of lip incompetence on the craniofacial morphology. The values of cephalometric parameters of competent lip seal and incompetent lip seal group were compared.

The open mouth posture was set by clinical examination. The subjects were asked to close their mouths. If the contraction of m. masseter and m. orbicularis oris was detected, the child was classified into the lip incompetence group. The contraction of muscles is a sign that lips are closed by difficulties.

The subject's mode of breathing – the mouth or nose breathing was not determined. The lip incompetence does not determine whether the child breathes through the nose, mouth or both. The open mouth posture does not reflect the mode of breathing[14].

Our results indicated that the values of interbasal angle (NSL/ML), the OccP/ML angle and the anterior lower facial height were significantly higher in the lip incompetence group. Lower central incisors are more protruded in the lip competent group. The sagittal skeletal relationships do not differ significantly between both groups, but the values of SNA and ANB angles are bigger in the open mouth posture group.

These results are similar to the findings of Hartgering and Vig who also found higher anterior lower facial height in the group with open mouth posture[14]. They claimed that increased lower anterior height could result in physical separation of the lips, especially in the growing child where vertical lip growth lags behind and has not yet caught up with skeletal growth. But they found no correlations between nasal resistance in relation to percent lower anterior facial height. The normal mouth posture was found even when airway adequacy was normal.

Fricke et al. also have shown the higher anterior lower facial height, increased value of inclination of mandible in relation to the cranial base and a larger angle between the mandible and maxilla. This is typical in patients with vertical growth pattern. But the correlation between open mouth posture and obstructed airways was not proven.

The incompetent lip seal can be observed in patients even after the removal of an obstruction or in patients with allergies of the upper airways. It can be also a manifestation of a general weakness in body posture with hypotonic muscles[15].

In conclusion, open mouth posture may take an important role in growth and development of craniofacial complex. It is very important to diagnose and to treat the lip incompetence as soon as possible.

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UTJECAJ INKOMPETENTNIH USNICA NA RAST I RAZVOJ KRANIOFACIJALNOG KOMPLEKSA

SAŽETAK

Pojava nenormalnih ili poremećenih orofacijalnih funkcija u periodu rasta i razvoja može dovesti do morfoloških anomalija kraniofacijalnog kompleksa. Svrha ovog rada je evaluacija utjecaja inkompetentih usnica na morfologiju kraniofacijalnog kompleksa. Oblik, veličina i odnosi koštanih dijelova kraniofacijalnog kompleksa analizirani su na lateralnim telerendgenogramima 84 djece: 45 djevojčica i 39 dječaka (dobi 8.96±0.66 godina). Uzorak je podijeljen u dvije grupe: na grupu djece sa i bez usnog dodira, tj. na grupu s kompetentnim i na grupu s inkompetentnim usnicama. Nađene su razlike u telerendgenskim parametrima između te dvije grupe djece.Vrijednosti inklinacije donjih centralnih inciziva (ILi/NB), interbazalni kut (NL/NSL), kut između okluzalne i mandibularne ravnine te prednja donja visina lica su signifikantno više u grupi djece koja imaju inkompetentne usnice. Sagitalni skeletalni odnosi se u obje grupe djece najviše razlikuju u vrijednostima ANB kuta, ali to nije statistički siginifikantno. Može se zaključiti da postav inkompetentnih usnica može imati značajan utjecaj na rast i razvoj kraniofacijalnog kompleksa.